Ewing Mountain Vegetation Project Environmental Assessment

Soil and Water Resources Report

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for:
Mt. Rogers National Recreation Area
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Significant Issue

There is concern that commercial timber harvesting, system road use/maintenance, temporary road construction, bladed skid roads/landings, skid trails, and herbicide use may adversely affect soil quality and function, hydrology, water quality, and aquatic habitats.

Methodology

Potential project effects to soil and water quality were assessed through field surveys, remote analysis, and modeling. A GIS analysis and quantitative erosion and sedimentation model of existing system roads, temporary roads, and bladed skid roads was performed.

Resource Indicators and Measures

Potential direct and indirect effects of project activities to soil and water quality are assessed through use of resource indicators:

1. Risk of detrimental soil disturbance in the project area.
2. Risk of sediment loading to water bodies.
3. Risk of chemical (herbicide) loading to water bodies.

The following resource measures are used to analyze potential effects to soil and water quality, and the likelihood of adverse effects:

1. The risk of detrimental soil disturbance (Page- Dumroese *et al* 2009) is measured by the extent of proposed temporary roads, skid roads, and log landings, and the extent of activities proposed on slopes > 35% grade.
2. The risk of sediment loading to water bodies is measured by the number (count) of proposed temporary road and skid trail channel crossings, and by the extent of potential detrimental soil disturbance in analysis watersheds.
3. The risk of sediment loading is also assessed using GRAIP Lite ArcGIS tools to model road-related sediment delivery to streams.
4. The risk of chemical loading is measured by the aerial extent (acres) of proposed herbicide use and proximity of use to riparian corridors and waterbodies.

Measures of soil disturbance are quantified based on assumed widths of temporary roads and skid trails, and aerial extents of log landings. Table 1 displays dimensions of temporary roads, skid road/trails, and log landings used in the analysis based on assumptions provided by George Washington-Jefferson NF staff.

Table 1. Dimensions of temporary roads, skid roads/trails, and log landings used to measure project effects.

Feature	Extent	Short-Term Disturbance	Long-Term Disturbance
Temporary Road	35’ wide	35’ wide	20’ wide
Bladed Skid Road	14’ wide	14’ wide	12’ wide
Unbladed Skid Trail	12’ wide	12’ wide	0
Log Landing	0.25 acres	0.25 acres	0.125 acres

Scope of the Analysis

The project area lies within three major drainage basins (5th-level HUC): Elk Creek-New River (71,622 acres), Crooked Creek-New River (78,541 acres), and Cripple Creek (88,817 acres) in Carroll, Grayson, and Wythe Counties, Virginia. Effects analysis is performed in the context of watersheds containing proposed activities. In consultation with the Forest Fish Biologist, eight smaller watersheds (smaller than the 6th-level HUC) were defined for effects analysis (Kirk 2020). These watersheds were chosen because it is expected that effects below these points in the channel networks would be immeasurable (Table 2).

Table 2. Analysis watersheds and proposed harvest unit area.

Watershed	Watershed Area ($Miles^2$)	Watershed Area (Acres)	Number of Treatment Units[1]	Total Unit Area (Acres)	% of Watershed Treated
Brush and Little Brush Creeks	19.9	12,736	25	752.6	5.9
Francis Mill Creek	6.4	4,096	2	28.5	0.7
UT[2] to New River	4.8	3,072	10	297.2	9.7
Cold Run	3.1	1,984	15	228.4	11.5
Powder Mill Branch	2.9	1,856	5	133.6	7.2
Cove Branch	2.4	1,536	6	155.5	10.1
UT[2] to Cripple Creek	1.7	1,088	5	122.9	11.3
Rock Creek	1.3	832	7	62.4	7.5

Effects to soil and water quality occur on different time scales (Table 3). Direct effects to soil quality occur where soil is subject to detrimental disturbance by grading of temporary roads, skid trails, and log landings (Page-Dumroese et al 2009). These soils are affected long-term and may require more than 100 years for site productivity and sustainability to recover (Howard 2019).

[1] Count contains units wholly or partially within the watershed
[2] Unnamed tributary (UT)

Direct effects to water quality occur at channel crossings where fine material in the stream banks and bed is disturbed and mobilized and produces turbidity. Indirect effects result when upland soil erosion or herbicides are mobilized and delivered to receiving waters. Effects to water quality are primarily short-term. Within two years after sale areas are closed herbaceous vegetation should become established from seed and volunteers on temporary roads, bladed skid trails, and log landings. This vegetation substantially reduces the risk of surface erosion and of sediment loading to waterbodies. Skid trails are expected to be covered with slash and this treatment should reduce the risk of surface erosion immediately after application, depending on site characteristics.

Table 3. Time scales of project effects to soil and water quality.

Resource	Short-Term Effects	Long-Term Effects
Soil Quality	< 100 years	> 100 years
Water Quality	2 years	NA

Environmental Consequences

Soils Existing Conditions

Proposed vegetation treatment units are contained within eight analysis watersheds (Table 2) and entirely within the Blue Ridge physiographic province. Predominant Natural Resource Conservation Service (NRCS) soil map units comprising the sale area were queried with the Web Soil Survey tool (NRCS 2020) and are displayed in Table 4.

Table 4. Predominant soil map units of the project sale area.

Soil	Name	Proposed Action Acres [3]	% of Proposed Action	Parent Material	Surface Texture	Soil Depth (inches)
75D	Lily gravelly sandy loam, 15 to 35% slopes	183	9.8	fine-loamy residuum from sandstone	gravelly sandy loam	27
WkE	Weikert very shaly silt loam, steep	177	9.5	residuum from sandstone and shale	very channery silt loam	22
140E	Sylco-Sylvatus complex, 35 to 60% slopes	173	9.2	residuum from interbedded phyllite, slate, fine-grained metasandstone	channery silt loam	36

[3] Acres and % of proposed action figures computed from analysis prior to modification of the proposed action and removal of 4 units totaling 60 acres.

Soil	Name	Proposed Action Acres [3]	% of Proposed Action	Parent Material	Surface Texture	Soil Depth (inches)
RmE	Ramsey very stony loam, steep	163	8.7	residuum from quartzite and/or shale and/or slate	very stony loam	19 to 29
140D	Sylco-Sylvatus complex, 15 to 35% slopes	150	8	residuum from interbedded phyllite, slate, fine-grained metasandstone	channery silt loam	36
57C	Clymer sandy loam, 3 to 15% slopes	90	4.8	residuum from sandstone, shale, siltstone	sandy loam	52
WkD	Weikert very shaly silt loam, moderately steep	78	4.3	residuum from sandstone and shale	very channery silt loam	22
46D	Dekalb cobbly sandy loam, 15 to 35% slopes, very stony	81	4.3	residuum from sandstone, quartzite	cobbly sandy loam	32
75C	Lily gravelly sandy loam, 3 to 15% slopes	79	4.2	residuum from sandstone	gravelly sandy loam	27
75E	Lily gravelly sandy loam, 35to 60% slopes	78	4.2	fine-loamy residuum from sandstone	gravelly sandy loam	27
826D	Keener loam, 15 to 35% slopes, very stony	74	3.9	colluvium from metasandstone, metaquartzite	loam	60+
96ES	Dekalb-Dekalb, shallow complex, 35 to 60% slopes, rubbly	71	3.8	residuum from sandstone, quartzite	cobbly sandy loam	32
CIC	Clymer fine sandy loam, sloping	68	3.6	Residuum from sandstone and shale and/or conglomerate and or quartzite	fine sandy loam	52 to 60
26D	Jefferson loam, 15 to 35% slopes	45	2.6	colluvium from sandstone and shale	loam	60+

Soil	Name	Proposed Action Acres [3]	% of Proposed Action	Parent Material	Surface Texture	Soil Depth (inches)
96DS	Dekalb-Dekalb, shallow complex, 15 to 35% slopes, rubbly	44	2.3	residuum from sandstone, quartzite	cobbly sandy loam	32
80D	Austinville silty clay loam, 15 to 35% slopes	35	1.9	residuum from dolomitic limestone and shale	silty clay loam	60+
4E	Chiswell-Groseclose-Litz complex,30 to 60% sloples	35	1.8	residuum from shale, siltstone, limestone, fine-grained sandstone	very channery silt loam	13
41E	Berks-Weikert complex, 35 to 60% slopes	20	1.1	residuum from acid shale	channery silt loam	26
46E	Dekalb cobbly sandy loam, 35 to 60% slopes, very stony	19	1	residuum from sandstone, quartzite	cobbly sandy loam	32

Sale area soils are derived mostly from sedimentary or meta-sedimentary parent material, are mostly loams, and range in depth from about 10" to greater than 60" (Table 4). It is expected that soils in the sale areas have not been subject to significant disturbance from previous Forest Service management activities. Undisturbed soils have adequate physical, biological, and chemical properties to maintain or improve vegetative growth, hydrologic function, nutrient cycling, and slope stability.

Water Quality Existing Conditions

According to the USFS Watershed Condition Framework (WCF) which assesses 12 watershed health indicators (USFS 2004), the northern half of the project area is considered to have "Properly Functioning" watershed conditions. However, the southern portion of the project in the Brush Creek watershed is rated "Functioning At Risk" due to "fair" ratings related to water quality, aquatic habitat, road/trail density, and invasive species and "poor" ratings for soils and fire conditions.

Throughout 2020, Forest Service personnel identified streams and wetlands within or adjacent to each harvest unit, and delineated these features as perennial, intermittent, or channeled ephemeral, such that Forest Plan standards to protect water quality and riparian corridors can be readily implemented. One municipal watershed for the unincorporated community of Austinville, VA (intake along the New River) overlaps the project boundary. Several units fall directly within the Surface Water Zone 1 (i.e. 5-mile upstream radius of an intake) and will be properly mitigated according to Forest Plan standards for municipal watersheds/public water supply. Surface water zone 1 is mapped per the Virginia Office of Drinking Water data (VDH 2017) and appropriate design criteria were applied, per Forest Plan standards, to reduce potential impacts to these drinking water resources.

State agencies conduct assessments of water quality every two years in accordance with Section 305(b) of the Clean Water Act. According to the *Virginia Water Quality Assessment 305(b)/303(d) Integrated Report,* all streams in the project area are fully supporting all beneficial uses or not assessed, except for drainages listed as impaired and shown below (VDEQ 2018).

Table 5. Water quality impaired stream segments (303d listed) and causes of impairment.

Watershed	Location	Cause	Source
Brush Creek	From the Lick Creek confluence near the Carroll/Grayson line, downstream	*Escherichia coli (E. coli)*	Source Unknown
Cripple Creek	Extends from Dean Branch confluence upstream to Francis Mill Creek confluence	*Escherichia coli (E. coli)*	Livestock (Grazing or Feeding Operations), Unrestricted Cattle Access

Water quality monitoring data collected by the USFS is presented in the aquatics/fisheries report. In summary, numerous streams within the project area have been sampled for macroinvertebrates and water chemistry and indicate overall good water quality status. Generally, water quality in the project area is not affected by the impairments listed above, given bacterial sources (fecal coliform and *E. coli*) are the result of concentrated livestock grazing or wildlife foraging along waterbodies. However, there is one active grazing allotment in the project area, which is permitted under an allotment management plan that requires management actions (such as exclosures) to protect the water quality of springs and streams across the allotment. The proposed action will not increase bacterial concentrations, and harvest units are upstream from agricultural practices on private lands where bacterial impacts are likely occurring. USFS silviculture management follows Virginia Department of Forestry best management practices as well as Forest Plan standards and design criteria to maintain and protect water quality (USFS 2014, VDOF 2011 and 2019).

Water quality existing conditions in the project area are influenced by state, county, forest service, and private roads, and the degree to which they are maintained. Sedimentation from forest roads can adversely affect water quality and aquatic habitat, and an analysis of the risk of erosion and sedimentation from existing forest roads and planned temporary roads and skid trails is presented in the report. Road stream crossings (culverts) on the FSR667 and FSR690 forest roads are known to be in disrepair and are planned for upgrade for aquatic organism passage (AOP). In addition, a segment of the FSR794 road has two failing culvert crossings and the end of the road along the stream has been obliterated by flood flows. This road will be considered for decommissioning.

No-Action Alternative

A “No Action” alternative was not specifically analyzed under the assumption that no action would maintain the status quo of soil and water quality and trends.

Proposed Action Alternative

Preliminary Logging Plan

The preliminary logging plan for the proposed action was provided as GIS data (Shaw 2021) and was used to assess potential project effects to soil and water quality. Table 6 summarizes proposed temporary road, skid road, and landing construction by analysis watershed.

Table 6. Proposed logging plan features by watershed.

Watershed	Watershed Area (miles^2)	Temporary Roads (miles)	Skid Road (miles)	Landings (count)
Brush and Little Brush Creeks	19.9	2.68	12.73	27
Francis Mill Creek	6.4	0.34	0.80	2
UT to New River	4.8	0.24	5.19	9
Cold Run	3.1	0.26	3.66	9
Powder Mill Branch	2.9	1.35	1.17	3
Cove Branch	2.4	0.68	2.78	6
UT to Cripple Creek	1.7	0.47	1.69	5
Rock Creek	1.3	0.00	1.24	0

Slope Analysis

An analysis of treatment unit slopes was performed with a digital elevation model (DEM). Of the 59 proposed treatment units 13 were characterized by slopes estimated to be in excess of 35% grade across at least 15% of the unit area (Appendix A). The estimated percent of individual unit areas on slopes over 35% grade ranged from 0 to approximately 50%. Appendix A contains a complete list of treatment units and areas estimated to be on slopes > 35%.

Heavy mechanical equipment operation on steep slopes risks damaging soils through displacement, rutting, compaction, and subsequent surface erosion. Forest-wide standards that tier to state-level Best Management Practices (BMP) are required to maintain soil productivity and sustainability (Forest Plan pg. 2-7):

__FW-1__: Resource management activities that may affect soil and / or water quality follow Virginia, West Virginia, and Kentucky Best Management Practices, State Erosion Control Handbooks, and standards in the Forest Plan.

The Virginia Department of Forestry recommends that overland log skidding be limited to slopes under 35% (VDOF 2011, 2019). Field-validation of steep slopes and application of this BMP during project implementation will prevent heavy mechanical equipment operation on slopes in excess of 35% thereby limiting short- and long-term soil disturbance.

Soil Quality

The risk of detrimental soil disturbance by watershed was estimated at approximately 2 to 47 acres short-term and 2 to 32 acres long-term (Table 7). The maximum proportion of proposed treatment area subject to short- and long-term soil disturbance was approximately 11% and 8%, respectively. The maximum proportion of the analysis watersheds impacted by short- and long-term soil disturbance was 0.7% and 0.5%, respectively.

Table 7. Estimated short- and long-term soil disturbance by acres, % of treated area, and % of watershed area.

			Total Acres Disturbed		% Treated Area Disturbed		% Watershed Area Disturbed	
Watershed	Area (Acres)	Treated Area (Acres)	Short-Term	Long-Term	Short-Term	Long-Term	Short-Term	Long-Term
Brush and Little Brush Creeks	12,736	807.4	46.5	31.8	6.2	4.2	0.4	0.2
Francis Mill Creek	4,096	28.5	3.3	2.2	11.6	7.8	0.1	0.1
UT to New River	3,072	303.1	14.3	10.4	4.8	3.5	0.5	0.3
Cold Run	1,984	228.4	9.6	7.1	4.2	3.1	0.5	0.4
Powder Mill Branch	1,856	133.6	9.2	5.7	6.9	4.3	0.5	0.3
Cove Branch	1,536	155.5	9.1	6.4	5.8	4.1	0.6	0.4
UT to Cripple Creek	1,088	122.9	7.4	4.9	6.0	3.9	0.7	0.4
Rock Creek	832	62.4	2.1	1.8	3.4	2.9	0.3	0.2

Long-term soil disturbance expected from the proposed action in the activity area is under the threshold established in Forest-Wide Water and Soil Quality Standards (Revised Land and Resource Management Plan Jefferson National Forest [herein Forest Plan], pg. 2-7):

***FW-5**: On all soils dedicated to growing vegetation, the organic layers, topsoil and root mat will be left in place over at least 85% of the activity area and revegetation is accomplished within 5 years.*

Harvest Equipment Operability

The Web Soil Survey tool (NRCS 2020) was used to assess soil limitations in proposed treatment units. Table 8 summarizes the risk of surface erosion, compaction, and suitability for heavy mechanical equipment operation for soils that make up about 90% of the proposed treatment units.

Table 8. Risk of soil erosion, compaction, and suitability for heavy mechanical equipment operation.

Soil	Name	Proposed Action Acres[4]	% of Proposed Action	Erosion Off-Road, Off-Trail	Compaction Susceptibility	Harvest Equipment	Hydrologic Group
75D	Lily gravelly sandy loam, 15 to 35% slopes	183	9.8	moderate	medium	moderate	B
WkE	Weikert very shaly silt loam, steep	177	9.5	severe	medium	moderate	D
140E	Sylco-Sylvatus complex, 35 to 60% slopes	173	9.2	severe	medium	poor	C
RmE	Ramsey very stony loam, steep	163	8.7	severe	high	moderate	D
140D	Sylco-Sylvatus complex, 15 to 35% slopes	150	8	severe	medium	moderate	C
57C	Clymer sandy loam, 3 to 15% slopes	90	4.8	moderate	high	well	B
WkD	Weikert very shaly silt loam, moderately steep	78	4.3	moderate	medium	moderate	D
46D	Dekalb cobbly sandy loam, 15 to 35% slopes, very stony	81	4.3	moderate	medium	moderate	A

[4] Acres and % of proposed action figures computed from analysis prior to modification of the proposed action and removal of 4 units totaling 60 acres

Soil	Name	Proposed Action Acres[4]	% of Proposed Action	Erosion Off-Road, Off-Trail	Compaction Susceptibility	Harvest Equipment	Hydrologic Group
75C	Lily gravelly sandy loam, 3 to 15% slopes	79	4.2	moderate	high	well	B
75E	Lily gravelly sandy loam, 35to 60% slopes	78	4.2	severe	medium	poor	B
826D	Keener loam, 15 to 35% slopes, very stony	74	3.9	severe	medium	moderate	B
96ES	Dekalb-Dekalb, shallow complex, 35 to 60% slopes, rubbly	71	3.8	severe	medium	poor	A
CIC	Clymer fine sandy loam, sloping	68	3.6	moderate	medium	well	B
26D	Jefferson loam, 15 to 35% slopes	45	2.6	very severe	high	moderate	A
96DS	Dekalb-Dekalb, shallow complex, 15 to 35% slopes, rubbly	44	2.3	moderate	medium	poor	A
80D	Austinville silty clay loam, 15 to 35% slopes	35	1.9	severe	medium	moderate	B
4E	Chiswell-Groseclose-Litz complex,30 to 60% sloples	35	1.8	very severe	medium	poor	D
41E	Berks-Weikert complex, 35 to 60% slopes	20	1.1	very severe	high	poor	B
46E	Dekalb cobbly sandy loam, 35 to 60% slopes, very stony	19	1	severe	medium	poor	A

Heavy mechanical equipment operations are not allowed on sustained slopes in excess of 35% per Forest Plan standards and State of Virginia Forestry Best Management Practices (VDOF 2011, 2019). This control will reduce the risk of surface erosion. In addition, a Timber Sale Administrator is expected to oversee on-site implementation, ensuring resource damage does not occur by enforcing BMPs and other design criteria and provisions specified in the timber sale contract. Suspension of harvest equipment operations is expected when conditions are deemed too wet, which will greatly reduce the risk of soil compaction resulting from project activities.

Soil Disturbance Monitoring

Following implementation of timber harvest projects, National Forests conduct resource-specific monitoring to assess whether plan standards were met, and if they provided necessary protections. The George Washington-Jefferson NF employs the National Soil Disturbance Monitoring Protocol (Page-Dumroese *et al* 2009) to assess the extent of detrimental soil disturbance resulting from timber harvest activities. Soil disturbance monitoring will be implemented in selected units across the Ewing Mountain project area after they are harvested to evaluate assumptions of the preliminary logging plan and any potential on-the-ground soil impacts.

Water Quality

Road-Stream Crossings

Direct and indirect short-term (within 2 years) effects to water quality are expected at and downstream of proposed road channel crossings. A GIS analysis of preliminary logging plan features (temporary roads and skid trails) and spatial stream channel data from field surveys and the forest's modeled *drain lines* dataset identified 35 potential channel crossings (Table 9). Stream channels were validated in the field by the USFS Center for Aquatic Technology Transfer (CATT) survey crew, the forest fish biologist, or hydrologist at 25 of the 35 identified crossings. In addition to temporary road and skid road crossings, four system road crossings were surveyed in the field and are included in Table 9. Two of these are existing, failing crossings on the FSR 794 road in the southeast part of the project area, and the other two are along an existing pasture access in the Pellbridge area, one of which crosses Cold Run, in the northwest part of the project.

Table 9. Proposed road channel crossings by analysis watershed.

Watershed	Channel Crossings (#)[5]	Field Surveyed
Brush and Little Brush Creeks	10	6
Francis Mill Creek	2	1
UT at New River	2	0

[5] Estimate based on intersection of proposed temporary roads and skid trails with forest's modeled *drain lines* dataset in GIS, and field-surveys.

Watershed	Channel Crossings (#)[5]	Field Surveyed
Cold Run	4	2
Powder Mill Branch	2	2
Cove Branch	2	2
UT at Cripple Creek	1	0
Rock Creek	2	2
Total	25	13

No timber harvest or ground disturbing activities will occur in protected riparian corridors for perennial and intermittent streams; and only partial harvest is allowed within channeled ephemeral corridors. New or temporary roads and skid roads should only cross the riparian corridor at designated crossings. Forest harvesting can directly affect water quality/quantity and surface hydrology if it alters the supply of sediment, peak flows or the frequency of high flows, and if it changes the structure of the stream channel by removing the supply of large wood that forms sediment storage sites. Bank erosion and lateral channel migration also contribute sediments if protective vegetation and living root systems are removed (Chamberlin *et al.* 1991). Through application of design criteria, Best Management Practices, and mitigation measures, these direct and indirect impacts can be largely avoided. The use and construction of system or temporary roads, skid roads and trails, and log landings increases the risk of sediment entering the stream system during pulses of wet weather. These travel ways should be constructed to minimize impacts to surface hydrology. Sediment loading in streams affects water quality directly through increases in turbidity or total dissolved solids, and indirectly as increases in water temperature and other parameters. Application of design criteria and Best Management Practices will minimize the potential for sedimentation of surface waters.

Channel crossings need to be positioned at designated locations, use improvement structures (e.g. culverts, temporary bridges), and be removed and rehabilitated (Forest Plan, pgs. 2-8 and 2-35):

> ***FW-12****: Motorized vehicles are restricted in the channeled ephemeral zone to designated crossings. Motorized vehicles may only be allowed on a case-by-case basis, after site-specific analysis, in the channeled ephemeral zone outside of designated crossings.*
>
> ***FW-20****: When crossing channeled ephemeral streams, culverts, temporary bridges, hardened fords, or corduroy are used where needed to protect channel or bank stability.*
>
> ***FW-21****: Construction of crossings is completed on all channeled ephemerals as soon as possible after work has started on the crossing. Permanent and temporary roads on either side of crossings within the channeled ephemeral zone are graveled.*

FW-129*: Skid trails may cross riparian corridors at designated crossings. If crossing a perennial or intermittent stream is unavoidable, use a temporary bridge or other approved method within the State Best Management Practices (BMPs). All streams are crossed at as close to a right angle as possible. Restoration of skid trails will occur as soon as possible to mitigate impacts.*

FW-132*: Temporary stream crossings will be removed and rehabilitated.*

In addition to forest-wide standards governing road-stream crossings the following standards pertain to activities in riparian corridors along defined perennial, intermittent, and channeled ephemeral streams.

Management Prescription 11 – Riparian Corridors

11-001*: Any human caused disturbances or modifications that may concentrate runoff, erode the soil, or transport sediment to the channel or water body are rehabilitated or mitigated to reduce or eliminate impacts. Channel stability of streams is protected during management activities.*

11-002*: Motorized vehicles are restricted to designated crossings. Motorized vehicles may be allowed on a case-by-case basis, after site-specific analysis, outside of designated crossings where it can be shown to benefit riparian resources.*

11-045*: New roads are located outside the riparian corridor except at designated crossings or where the road location requires some encroachment; for example to accommodate steep terrain, or are allowed within the corridor if the road will cause more resource damage if it were located outside the corridor. When existing roads within riparian corridor are causing unacceptable resource damage, appropriate mitigation measures will be implemented.*

11-046*: In-stream use of heavy equipment or other in-stream disturbance activities is limited to the amount of time necessary for completion of the project. Construction of crossings is completed on all streams as soon as possible after work has started on the crossing. Permanent and temporary roads on either side of stream crossings within the riparian corridor are graveled.*

11-047*: When constructing roads, each road segment will be stabilized prior to starting another segment. Stream crossings will be stabilized before road construction proceeds beyond the crossing.*

11-048*: To minimize the length of streamside disturbance, ensure that approach sections are aligned with the stream channel at as near a right angle as possible. Locate riparian corridor crossings to minimize the amount of fill material needed and minimize channel impacts. Generally, permanent structures or temporary bridges on permanent abutments are provided when developing new crossings on perennial streams. Permanent structures, temporary bridges or hardened fords are used when crossing intermittent streams.*

11-049*: Design structures (culverts, bridges, etc.) to accommodate storm flows expected to occur while the structures will be in place. Use scientifically accepted methods for calculating expected storm flows.*

> ***11-050****: Design crossings so stream flow does not pond above the structure during normal flows in order to reduce sediment deposition immediately above the crossing and maintain the channel's ability to safely pass high flows.*
>
> ***11-051****: Design the crossing so that stream flow will not be diverted along the road if the structure fails, plugs with debris, or is over-topped.*
>
> ***11-052****: If culverts are removed, stream banks and channels must be restored to a natural size and shape. All disturbed soil must be stabilized.*
>
> ***11-053****: Fords associated with new road construction are not used in perennial streams without site-specific environmental analysis. Establish fords only under conditions that will not cause significant streambank erosion. Erosion stone or larger rock is used to increase load bearing strength at the water/ land interface.*
>
> ***11-054****: All new stream crossings will be constructed to allow the passage of aquatic organisms and maintain natural flow regime. Exceptions may be allowed in order to prevent the upstream migration of undesired species.*

These standards reduce the risk of sediment loading to water bodies. Effects to water quality are expected from storm events during implementation and after sale areas close but before herbaceous vegetation is established on skid trails. These effects are not expected to persist beyond the short-term (2 years).

Forest Road 794 in the southeast of the project area has two failing culvert crossings and the end of the road has been obliterated by flood flows. The total length of this road is approximately 1.1 miles and the approximately 0.8 mile segment below the saddle will be considered for decommissioning. Rehab of this segment would reduce the risk of sedimentation of the perennial creek it follows and receiving waters further downstream.

<u>Aquatic Organism Passage Improvement</u>

Culverted channel crossings on the 667 and 690 roads are being planned for improvement (Parish 2021). Recently two road stream crossings in the Lick Ck watershed were upgraded for AOP by replacing existing undersized culverts with larger bottomless arch structures. These structures improve aquatic organism movement and also flood resilience of the road stream crossing. The planned upgraded on the 667 road crossing is expected to follow a similar design and construction approach.

In the short term (two years) this work has the potential to increase sediment loads at the crossing site and to downstream reaches. Where soil and vegetation are disturbed by site access, excavation, stockpiling, and construction activities water is more likely to mobilize sediment to the stream channel. Excavation activities may occur in moist soils immediately adjacent to the stream which elevates the risk of sedimentation. After two years it is expected that vegetation will have stabilized any disturbed soil. Immediately after construction is completed the risk of erosion and sedimentation due to flood damage of the crossing will be reduced because the new structure will be designed and constructed to accommodate larger flow events without damage and erosion and sedimentation.

Water quality may also be adversely impacted through the introduction of chemicals (e.g., petroleum products) used with machinery working in and around stream channels. Depending on how and where the chemicals contact water, impacts to surface and groundwater may be short- or long-lived. Construction plans of operation will include protocols and equipment for spill prevention and mitigation to reduce this risk.

GRAIP Lite Sediment Modeling

The Geomorphic Roads Analysis and Inventory (GRAIP) Lite model (Nelson *et al* 2019) was used to assess road-related sediment impacts to streams. The model was developed at the USFS Rocky Mountain Research Station (RMRS) and is run in ArcGIS. The model estimates sediment production from road segments, and delivery to stream channels based on the following attributes for road segments using a DEM:

- Route status (e.g. existing, decommissioned, planned)
- Operational maintenance level (1, 2, 3, 4, 5)
- Surface type (native, crushed rock, paved)

Sediment production from Forest Service and non-Forest Service roads was modeled to quantify existing conditions in the analysis watersheds. Subsequently, sediment from proposed temporary roads and skid trails was modeled to assess potential project effects. Proposed temporary roads and bladed skid roads were modeled as maintenance level 2 roads with native surfacing in GRAIP Lite. Landings are non-linear features and are frequently located on or immediately adjacent to roads and were not treated separately in the model. In addition, overland skid trails are not bladed surfaces and were not included in the model. As such model results may be considered a minimum estimate of erosion and sedimentation associated with logging plan features.

Model results for the eight analysis watersheds are displayed in Table 10. Existing road-related sediment loading is estimated to range from about 0.4 (Rock Ck) to 5.0 (Francis Mill ck) metric tons per square kilometer per year for the watersheds. These results are reasonable given the character of the watersheds and the extent of their existing road networks (Luce 2020). This range is 0 to 0.02 US tons per acre per year.

The estimated increase in sediment loading under the initial proposed action ranged from 0 (in four watersheds) to 2 (Cove Branch) metric tons per square kilometer per year and 0 to about 190% over estimated background rates (Table 10). The large increase in Cove Branch was related to a temporary road segment proposed near a stream channel for approximately 1,000 feet. The proposal was subsequently modified, and the temporary road was located further away from the stream. Similarly, the approximately 20% increase predicted in the Cold Run watershed is related to a proposed temporary road segment accessing a treatment unit east of Cold Run which has subsequently been dropped. These changes will reduce sediment loading below what is displayed in Table 10.

Model estimates of road-related sedimentation of watercourses are reported on an annual basis. Skid trails are expected to be covered with logging slash prior to the sale areas being closed. Temporary road segments are rehabilitated with either logging slash or seeding. This rehabilitation work, along with natural regeneration of herbaceous and woody vegetation should reduce the risk of sedimentation from project temporary roads and skid trails after Year-1 post-project. However, sedimentation from system roads would persist at rates estimated by the existing conditions model outputs.

Table 10. GRAIP Lite erosion and sedimentation model results by analysis watershed.

		Sediment Delivery to Watershed Pour Point				
		Existing Conditions		Proposed Action		
Watershed	**Watershed Area (Acres)**	**tonnes/km^2/yr.**	**US tons/acre/yr.**	**tonnes/km^2/yr.**	**US tons/acre/yr.**	**% Increase**
Brush and Little Brush Creeks	12,736	3.86	0.02	4.33	0.02	12
Francis Mill Creek	4,096	4.95	0.02	4.95	0.02	0
UT to New River	3,072	1.92	0.01	1.92	0.01	0
Cold Run	1,984	3.00	0.01	3.62	0.02	21
Powder Mill Branch	1,856	0.58	0.00	0.62	0.00	7
Cove Branch	1,536	1.12	0.00	3.24	0.01	189
UT to Cripple Creek	1,088	3.87	0.02	3.87	0.02	0
Rock Creek	832	0.35	0.00	0.35	0.00	0

Sedimentation rates displayed in Table 10 are calculated as a maximum total % increase assuming all areas are harvested in a single year. However, timber sales are often spread out over time and therefore maximum impacts are expected to be reduced. In addition, required road maintenance for pre-haul, hauling, and post haul on system roads will take place in accordance with the Virginia Department of Forestry Best Management Practices guideline and will further reduce effects to soil and water resources (VDOF 2011, 2019). For any watershed showing a potential increase of >10% sediment delivery above background, site specific design criteria will be prescribed for the road system or logging plan features that were identified by the GRAIP Lite model as potential sources of sediment loading. These design criteria will take the form of enhanced BMPs and can include silt fence installation, rapid revegetation, spot gravelling and temporary stabilization measures during wet weather conditions. Lastly, monitoring according to the USFS National Best Management Practices Program (USFS 2012), which was developed to improve management of water quality consistent with the Federal Clean Water Act (CWA) and State water quality programs, will be implemented where deemed necessary and appropriate across the project area to evaluate soil and water impacts from the proposed action.

Herbicide Use

Indirect, short-term effects to water quality could occur if herbicide applied in upland areas is mobilized and delivered to receiving waters. The Forest Plan requires a buffer of 30 linear feet from streams when applying herbicides, and no herbicide application is allowed in standing water that could potentially carry into streams. Additionally, Glyphosate and triclopyr are not soil active substances, meaning the herbicides do not adhere to soil particles once applied and therefore, it is not expected that water quality could be impacted if erosional processes do create paths to water bodies. The use and effects of such chemicals on USFS land has been previously analyzed and documented in the Forest-Wide Non-Native Invasive Plant Control EA (USFS 2010). All application protocols will be followed to protect water quality and negligible impacts to water quality from herbicide use are expected from the proposed action.

Cumulative Effects of Past, Present and Foreseeable Future Actions

Effects of Forest Service and non-Forest Service roads and skid roads on soil and water quality in the analysis watersheds is ongoing and not expected to change appreciably in the foreseeable future. These effects are quantified by the GRAIP Lite model in the previous section of the report. Legacy detrimental soil disturbance from previous timber harvest features (temporary roads, bladed skid roads, and log landings) is likely still present in the analysis watersheds, but these activities are not still producing measurable water quality effects. No other timber harvest projects are currently planned in the area.

Cumulative Effects of Prescribed Burning

It is reasonable and foreseeable that prescribed burning will be used post-harvest as a management tool to achieve silvicultural prescriptions and desired conditions. Erosion and sedimentation from dozer lines pose the greatest risk from the prescribed burning activity. Forest personnel plan to use existing features on the landscape as fire breaks, such as roads and trails, where available, in order to minimize dozer line and potential erosion. Hand line and dozer lines are rehabilitated after use, further reducing impacts to water quality and soils. Recent research on the Forest showed no change in water quality following a wildfire event that burned the entire watershed (Downey and Haraldstadt 2013). Additionally, prescribed fire is typically of low to moderate intensity and does not produce adverse effects to soil or water quality (Caldwell 2020).

Based on previous monitoring, recent research, and plan standards, there will be limited direct and indirect effects and negligible cumulative effects to water quality and soils from prescribed burning.

Cumulative Effects of Historic Mine Remediation

The watersheds in the project area and surrounding areas have been historically mined and remediated through mine closure processes over time. However, in a few instances, remediation efforts need maintenance to ensure sites remain in stable conditions. For the Glade Mountain abandoned mine site, which drains to Killinger Creek and is tributary to Cripple Creek, a portion of the remediation infrastructure has failed over time, including earthen impoundments and gabion structures, which resulted in significant pulses of sediment to enter these water bodies. Following several high-intensity rain events in 2017, 2019 and 2020, severe downcutting of channels occurred resulting in sediment transport and high turbidity levels. The Virginia Department of Mines, Minerals and Energy (VDMME), through their Division of Mineral Mining and Orphaned Lands Program, has partnered with the Forest staff to inventory/assess the Glade Mtn Mine site and provide a comprehensive stabilization plan (VDDME 2020). The stabilization measures outlined in the plan are expected to be implemented in the near future. Once the remediation effort is deemed effective at reducing erosion and sedimentation, timber harvest activities may proceed as planned in the Cripple Creek watershed.

Cumulative Effects of Livestock Grazing

Livestock grazing has the potential to impact soil and water resources in numerous ways. Trampling of stream banks or springs when animals are accessing water sources can lead to bank destabilization and sediment to enter the water body, as well as feces entering water bodies, which can be a substantial impact on water quality and downstream beneficial uses. Consumption of vegetation and the resulting loss of ground cover and soil compaction through hoof action can lead to higher levels of erosion, storm runoff and less percolation. Adherence to the allotment management plan standards and conditions, along with allotment monitoring can minimize cumulative effects on soil and water resources. Outstanding allotment plan requirements such as fencing a spring in the Cold Run watershed should be implemented prior to timber harvest operations. This improvement would reduce cumulative effects to soil and water resources.

Cumulative Effects of Recreational Horse Trails

Cross-county horse trails are common throughout the project area. There is concern that access developed for the timber sale will continue to be used as unauthorized/non-system horse trails and further contribute to erosion and sedimentation. There are currently several known non-system horse trails that have resulted in resource damage such as trail gullying, riparian and stream channel impacts through trampling and hoof action, and chronic erosion off certain portions of trail. The GRAIP Lite model can be used to predict site-specific horse trail segments that are potential sources of sediment loading. Monitoring of these locations, along with trail maintenance and BMP installations can reduce these cumulative sediment impacts to water quality and aquatic habitat and overall reduce soil loss in the first place.

Consistency with Relevant Laws, Regulations, and Policy

Federal Law

Clean Water Act

The Federal Water Pollution Control Act, (Clean Water Act) (33 USC 1251, 1254, 1323, 1324, 1329, 1342, 1344) as amended, intends to restore and maintain the chemical, physical, and biological integrity of the nation's waters. Required are (1) compliance with State and other federal pollution control rules, (2) no degradation of in-stream water quality needed to support designated uses, (3) control of non-point source water pollution by using conservation or "best management practices", (4) federal agency leadership in controlling non-point pollution from managed lands, and (5) rigorous criteria for controlling discharge of pollutants into waters of the United States.

Forest Service Policy

Forest Service Manual Sections 2532.02, 2532.03

Describes the objectives and policies relevant to protection (and, where needed, improvement) of water quality on National Forest System lands so that designated beneficial uses are protected.

Forest Service Manual Section 2509.22

Describes the policies and objectives relevant to soil and water conservation practices, the practices themselves, and directs the Forest Service to implement these measures as a means of preventing or mitigating non-point source pollution.

Forest Service Manual Chapter 2550

The National Soil Management Handbook defines soil productivity, components of soil productivity, and establishes guidance for measuring soil productivity. In determining a significant change in productivity, a 15 percent reduction in inherent soil productivity potential will be used as a basis for setting threshold values. Threshold values would apply to measurable or observable soil properties or conditions that are sensitive to significant change. The threshold values, along with areal extent limits, would serve as an early warning signal of reduced soil productive capacity, where changes to management practices or rehabilitation measures may be warranted.

Adherence to the Forest Plan and Virginia's Forestry BMP is expected to protect soil and water quality in compliance with the Clean Water Act and the Forest Service Manual.

Land and Resource Management Plan

Relevant Forest Plan standards are included previously in the report.

Design Criteria

In addition to Forest Plan standards that need to be adhered to, the following project-specific design criteria are proposed to minimize risks to soil and water quality:

1. Brush/Little Brush Creeks, Cold Run, Cove Branch watersheds - site specific design criteria may be needed for the road system or logging plan features that were identified by the GRAIP Lite model as large potential sources of sediment loading and are validated as such in the field. Enhanced BMPs including (but not limited) to silt fence installation, rapid revegetation, spot gravelling and temporary stabilization measures during wet weather conditions may be required to further reduce potential sediment impacts on water quality and aquatic habitat.
2. Close temporary roads and skids roads with enough jack-strawed trees and slash, or other means, to effectively prevent unauthorized vehicle or horse use, where necessary. This is specifically a concern where non-system horse trails are proposed as project temporary roads or skid roads/trails, or where they intersect. Signage and effectiveness monitoring will also be required.
3. No units will be sold within the Cripple Creek watershed until after the Glade Mine reclamation is completed and has been determined effective at reducing the risk of erosion and sedimentation into Killinger Creek.

Other Relevant Law, Regulation, or Policy

Virginia's Forestry Best Management Practices

Adherence to Virginia's Forestry Best Management Practices for Water Quality (VDOF 2011, 2019) is required by the Forest Plan (Forest-wide Water and Soil Quality Standard 1). The following sections of the VA BMP manual are relevant to the project:

- Skid Trails
- Stream Crossings
- Log Landings
- Erosion Control Measures
- Revegetation

Conclusion

The project proposed action is expected to produce detrimental soil disturbance within limits established by the Forest Plan. It is also anticipated that water quality may be marginally affected by sediment loading over the short-term, but measurable long-term water quality effects resulting from the proposed action should not occur if Forest Plan standards, Virginia's Forestry BMP, and additional design criteria at identified sediment loading sources are adhered to. Further, water quality is not expected to be affected by herbicide use under the Proposed Action. No substantial impacts are expected to drinking water. Potential water quality effects will be spread out over time, with vegetative recovery establishing quickly post-harvest, minimizing effects to soil and water resources.

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Appendix A

Slope Analysis of Proposed Treatment Units

Unit [6]	Area < 35% Slope (acres)	Area > 35% Slope (acres)	Total Area (acres)	Percent > 35% Slope
C4970 S2	7.0	0.0	7.0	0%
C4970 S3	30.7	0.0	30.7	0%
C4970 S5	30.3	0.0	30.3	0%
C4970 S6	7.0	0.0	7.0	0%
C4970 S7	12.1	0.0	12.1	0%
C4970 S10	14.5	0.0	14.5	0%
C4970 S11	11.4	0.0	11.4	0%
C4970 S12	8.3	3.1	11.3	27%
C4970 S22	24.9	0.0	24.9	0%
C4970 S35	11.9	3.8	15.6	24%
C4970 S39	24.1	0.4	24.5	2%
C4970 S55	16.1	0.0	16.1	0%
C4970 S66	16.3	2.6	18.8	14%
C4970 S71	18.2	1.7	19.9	9%
C4970 S87	10.8	1.6	12.3	13%
C4971 S1	21.9	0.3	22.2	1%
C4971 S2	11.6	0.0	11.6	0%
C4971 S5	31.5	0.0	31.5	0%
C4971 S7	8.5	2.3	10.8	21%
C4971 S8	23.1	0.0	23.1	0%
C4971 S14	21.4	1.9	23.3	8%
C4971 S17	63.0	10.4	73.4	14%
C4972 S1	38.8	6.0	44.8	13%
C4972 S4	7.2	6.4	13.7	47%

[6] Five units (C4970 S89, C4976 S19, C4976 S20, C4976 S46, and C4978 S22) were removed from the original analysis and do not appear in Appendix A

Unit [6]	Area < 35% Slope (acres)	Area > 35% Slope (acres)	Total Area (acres)	Percent > 35% Slope
C4972 S36	31.3	2.7	34.0	8%
C4972 S41	16.0	1.9	17.9	10%
C4973 S7	43.5	13.3	56.7	23%
C4973 S15	112.1	3.5	115.7	3%
C4973 S25	37.7	2.0	39.7	5%
C4974 S5	10.6	6.4	17.1	38%
C4974 S22	8.9	0.0	8.9	0%
C4974 S29	25.2	2.7	27.9	10%
C4976 S13	20.2	5.0	25.2	20%
C4976 S21	45.1	3.0	48.1	6%
C4977 S1	35.8	0.0	35.8	0%
C4977 S1	2.7	0.0	2.7	0%
C4977 S9	54.3	7.0	61.2	11%
C4977 S14	8.7	1.4	10.1	14%
C4977 S14	10.5	1.6	12.1	13%
C4977 S16	40.0	16.7	56.6	29%
C4977 S21	0.1	0.0	0.1	17%
C4977 S22	12.4	11.6	24.0	48%
C4977 S23	40.5	5.4	45.9	12%
C4977 S29	22.5	5.0	27.5	18%
C4977 S31	10.0	0.7	10.6	6%
C4978 S2	38.5	0.4	39.0	1%
C4978 S10	8.6	1.3	9.9	13%
C4978 S13	82.8	1.0	83.9	1%
C4978 S17	89.0	0.3	89.3	0%
C4978 S19	8.1	0.0	8.1	0%
C4979 S4	65.3	0.0	65.3	0%
C4979 S8	53.7	0.0	53.7	0%

Unit [6]	Area < 35% Slope (acres)	Area > 35% Slope (acres)	Total Area (acres)	Percent > 35% Slope
C4979 S22	35.7	0.0	35.7	0%
C4983 S1	15.9	0.0	15.9	0%
C4983 S2	13.3	0.0	13.3	0%
C4983 S5	37.4	5.8	43.1	13%
C4984 S3	31.2	0.7	31.9	2%
C4984 S11	53.1	14.9	68.0	22%
C4984 S15	23.3	0.0	23.3	0%
C4984 S16	10.9	0.0	10.9	0%
C4984 S17	3.7	0.0	3.7	0%
C4970 S2	7.0	0.0	7.0	0%
Grand Total	**1,629.2**	**154.8**	**1,783.6**	